



U.S. Department of Energy
Energy Efficiency and Renewable Energy

DOE SSL Commercial Product Testing Program (CPTP)

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Voices for SSL Efficiency: DOE SSL Workshop
Boston



Outline: Commercial Product Testing Program

- Purposes of CPTP
- Testing program scope
- Methods & process
- Progress to date
- Round 1 & 2 results
- Where to go for more info



Purposes of CPTP

- Provide objective, high quality performance information
- Know performance of market available products
 - To support R & D planning
 - To support ENERGY STAR®
- Inform industry test procedures and standards development
- Discourage low quality products
- Reduce SSL market risk due to buyer dissatisfaction from products that do not perform as claimed



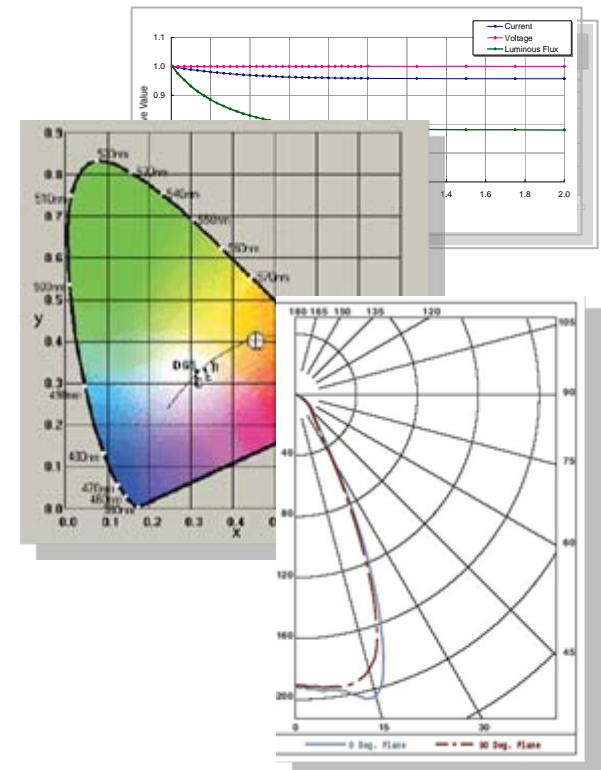
**YOU MAY NEVER CHANGE
ANOTHER LIGHT BULB**

- ✓ *Long life*
- ✓ *Energy efficient*
- ✓ *Easy to install (standard socket)*
- ✓ *Natural white, superb color rendering*



Testing Program Scope

- Commercially-available SSL products for the general illumination market
 - Luminaires (white light)
 - Indoor and outdoor
 - Residential and commercial
- Testing for
 - Luminaire light output, efficacy
 - Power, thermal characteristics
 - Beam and intensity
 - Lumen depreciation
 - Spectral power distribution, CCT, CRI
 - Benchmarking (other light sources)





Testing Program Process

- Quarterly product selection & acquisition
- Multiple independent test labs
- Assembly and analysis of results
 - Courtesy sharing of results with manufacturers
 - Retesting options
- Publication of results
 - Summary reports
 - Detailed test reports
- “No Commercial Use” Policy



Photo credit: Luminaire Testing Laboratory



Progress to Date

- Quarterly rounds of testing
 - Selection → Acquisition → Testing → Analysis → Reports
- Current Status
 - Pilot testing completed
 - Round 1 completed
 - Round 2 completed
 - Round 3 testing underway
 - Round 4 selection commencing

The screenshot shows a web browser window titled "Solid-State Lighting: REQUEST FOR DETAILED TEST REPORT - Microsoft Internet Explorer". The address bar shows the URL "http://www.nrel.gov/ssl/testing_request.htm". The page header includes the U.S. Department of Energy logo and the text "Energy Efficiency and Renewable Energy". The main content area is titled "Building Technologies Program" and "Solid-State Lighting". It features a sidebar with navigation links such as "Why Invest in SSL?", "SSL Portfolio", "SSL Partnership", "R&D Project Portfolio", "R&D Highlights", "Current LED Projects", "Current OLED Projects", "Completed LED Projects", "Completed OLED Projects", "Commercialization Support", "ENERGY STAR", "Commercial Product Testing Program", "Standards Development", "Using LEDs for General Illumination", "LED Basics", "Energy Efficiency", "Color Quality", "LED Life", "Thermal Management", "LED Applications", "Packaged Downlighting", and "FAQs on Market". The main content area is titled "DOE SSL Commercial Product Testing Program" and "REQUEST FOR DETAILED TEST REPORT". It asks the user to provide the following information: "First Name*", "Last Name*", "Organization*", "Email*", and "Phone*". Below this, it asks the user to "Select the report(s) that you would like to receive." and provides a list of checkboxes: "06-11 Task/desk", "06-06 Surface mount", "06-05 Outdoor area", "06-04 Task", "06-03 Downlight", "06-02 Undercabinet (updated)", and "06-01 Downlight". There is also a checkbox for "Yes, I agree to abide by the DOE SSL Commercial Product Testing Program NO COMMERCIAL USE POLICY*". A "Submit" button is located at the bottom right of the form.



CPTP Round 1 & 2 Results

- 25 products tested
- Focus: overall luminaire performance
- Wide range in products & results
- Small sample size, more testing Round 3





Examples of CPTP Results

| | <i>Manufacturer Published LED Luminous Efficacy</i> | Light Output (lumens) | Luminaire Efficacy (lm/W) | Correlated Color Temperature (K) | Color Rendering Index |
|--|---|----------------------------------|--|---|----------------------------------|
| SSL Downlights | | | | | |
| CPTP 06-01 | <i>40 lm/W</i> | 193 | 12.8 | 3012 | 70 |
| CPTP 06-03 | <i>45 lm/W</i> | 298 | 19.4 | 2724 | 67.3 |
| SSL Undercabinets | | | | | |
| CPTP 06-02 | <i>55 lm/W</i> | 166 | 16.1 | 3483 | 78.2 |
| CPTP 06-08 | | 375 | 21.6 | 7003 | 72.3 |
| CPTP 06-10 | | 166 | 32.8 [21.9] | 4103 | 77.3 |
| SSL Task/Desk Lights | | | | | |
| CPTP 06-04 | <i>36 lm/W</i> | 114 | 11.6 [7.1] | 6392 | 76 |
| CPTP 06-09 | | 328 | 15.3 [11.6] | 3841 | 84.9 |
| CPTP 06-11 | | 215 | 17.0 [8.2] | 5973 | 74 |
| CPTP 07-03 | | 226 | 18.4 [8.6] | 5939 | 74 |
| Adjusted efficacy values in brackets [] include the effect of measured off-state power consumption assuming 3 hours on-time per day. | | | | | |

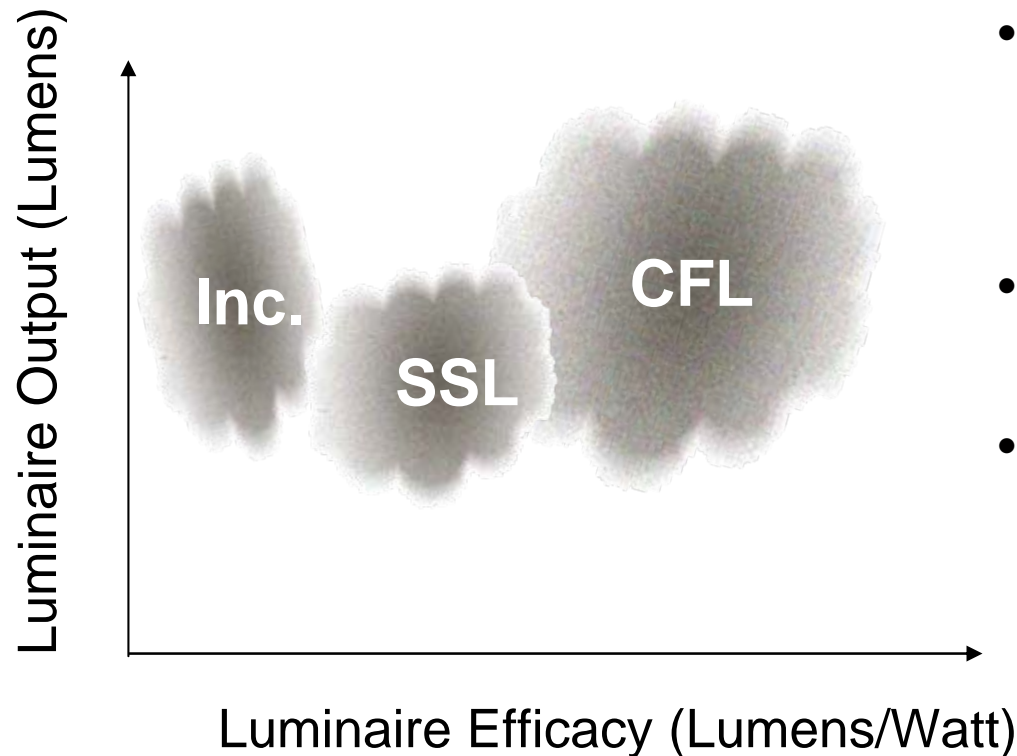


Examples of CPTP Results

| DOWNLIGHTS | | | | | |
|---|--|----------------------------|----------------------------|---|--------------------------------------|
| | <i>Manufacturer Published Output or Efficacy</i> | Output (lumens) | Efficacy (lm/W) | Correlated Color Temperature (K) | Color Rendering Index |
| R30 Replacement Lamps | | | | | |
| CPTP 07-08, Warm White | <i>400 lm</i> | 239.1 | 27.1 | 2945 | 71.8 |
| CPTP 07-09, Cool White | <i>500 lm</i> | 310.3 | 34.1 | 5973 | 81.9 |
| CPTP 07-13, Warm White, RGB | <i>400 lm</i> | 405.6 | 25.9 | 2689 | 14.45 |
| CPTP 07-14, Cool White, RGB | <i>400 lm</i> | 351.6 | 25.4 | 4006 | 13.3 |
| Downlights (complete luminaires) | | | | | |
| CPTP 06-01, Downlight | <i>40 lm/W (LED)</i> | 193 | 12.8 | 3012 | 70.0 |
| CPTP 06-03, Downlight | <i>45 lm/W (LED)</i> | 298 | 19.4 | 2724 | 67.3 |
| CPTP 07-04, Downlight | <i>477 lm</i> | 356.7 | 11.6 | 5964 | 76.4 |
| CPTP 07-05, Downlight | <i>642 lm</i> | 662.2 | 25.3 | 4402 | 76.0 |
| A-lamp Replacement Lamps | | | | | |
| CPTP 07-06, A19 | <i>27 lm</i> | 10.3 | 15.7 | 3161 | 70.4 |
| CPTP 07-12, A-lamp (~A17) | <i>"Electricity consumption reduced 80- 90%"</i> | 19.7 | 13.4 | 25263 | 79.1 |



Energy Use and Light Output



General Observations

- Luminaire outputs: comparable for some applications
 - Undercabinets
 - Desk/Task
- Luminaire efficacies
 - SSL surpasses incandescent
 - SSL \rightarrow $\frac{1}{2}$ to $\frac{3}{4}$ CFL
- Caution:
 - Small sample size
 - SSL evolving
 - More benchmarking
 - More testing



Direct CFL/LED Comparison

- Same desk/task light, two different sources

| | CFL | LED |
|---------------------------|------|------|
| Luminaire Output (lm) | 236 | 226 |
| Luminaire Efficacy (lm/W) | 24.2 | 18.4 |
| CCT | 3432 | 5939 |
| CRI | 79 | 74 |
| Power Factor | 0.54 | 0.92 |



Off-State Power Concern

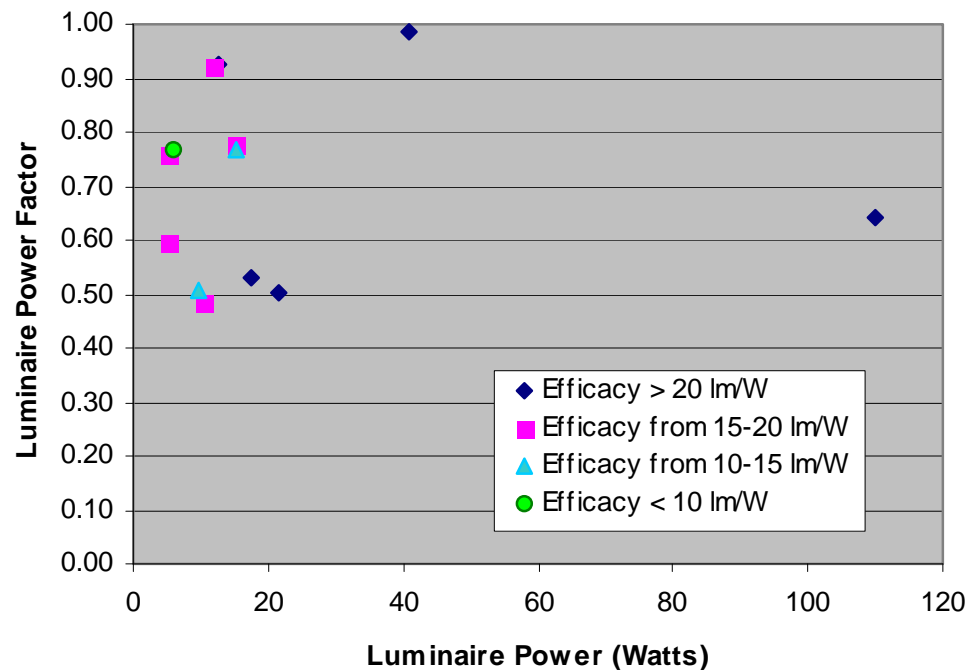
- Luminaires with on-off switches
 - 18 lm/W → 9 lm/W (for 3 hours on per day)

| Table 2. Effective Average Efficacy | | | | | | |
|---|-----|--------------------------------------|---------------------------------|-----------------------------------|--------------------|--------------------|
| | | Measured Efficacy w/ Power On (lm/W) | Measured Power in Off State (W) | Effective Average Efficacy (lm/W) | | |
| | | | | 1 hour on per day | 3 hours on per day | 5 hours on per day |
| CPTP 06-04 Task Light | | 11.6 | 0.88 | 3.8 | 7.1 | 8.7 |
| CPTP 06-09 Task/Desk | | 15.3 | 0.98 | 7.4 | 11.6 | 13.0 |
| CPTP 06-10 Undercabinet | | 32.8 | 0.36 | 12.4 | 21.9 | 25.8 |
| CPTP 06-11 Task/Desk | | 17.0 | 1.96 | 3.7 | 8.2 | 10.7 |
| CPTP 07-02 Task/Desk | CFL | 24.2 | 1.14 | 6.6 | 13.3 | 16.8 |
| CPTP 07-03 Task/Desk | LED | 18.4 | 2.00 | 3.9 | 8.6 | 11.4 |
| Note that units operated for fewer hours per year will consume less energy, despite lower efficacies. | | | | | | |



Round 1 Results: Power Factors

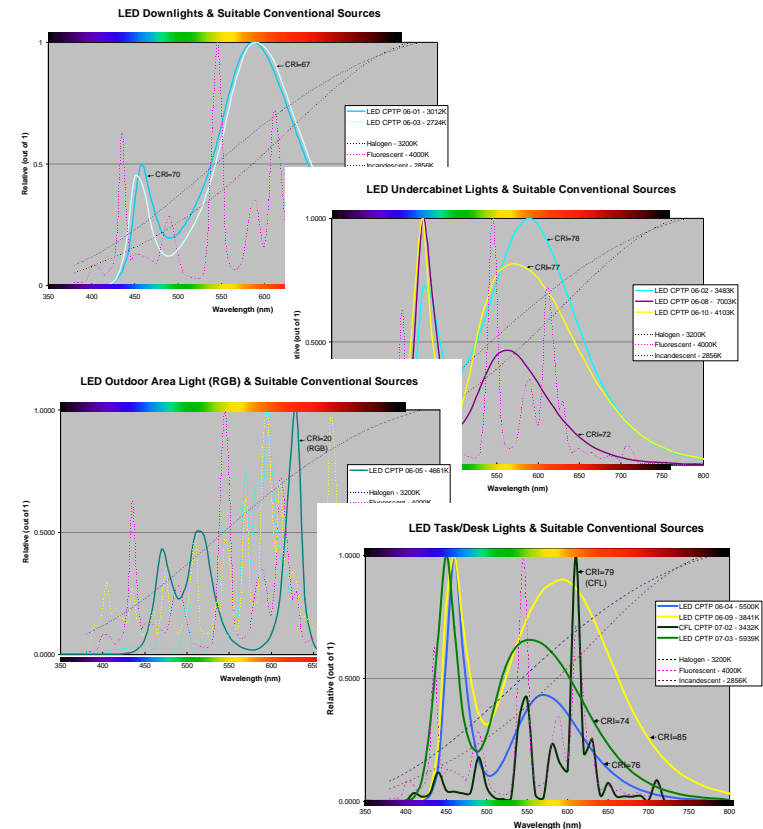
- Range of values
 - 0.5 to 1.0
- Small sample size for now
 - No PF/efficacy correlation
 - No PF/power correlation





Round 1 & 2 Results: Color Qualities

- Range of color qualities
 - CCT range: 2689 K to 36000 K
 - Phosphor-conversion LEDs CRI range: 67-85
 - Three RGB luminaires tested

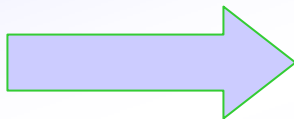




CPTP Round 1 & 2 Key Conclusions

- Wide range of performance in SSL luminaires
 - Misleading product literature
- CPTP positive influences
 - Market/industry awareness & involvement
 - Testing standards validation & refinement

Round 1 & 2 products designed in 2005-2006,
showing some LED luminaires rivaling some CFL
luminaires in output and efficacy

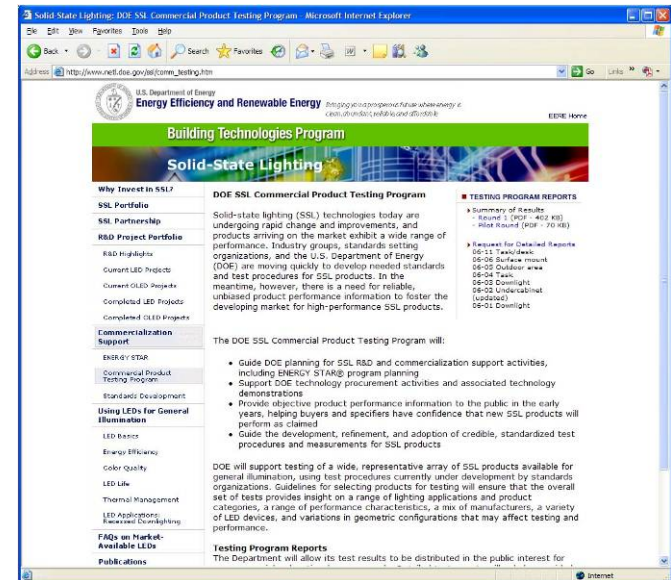


Great promise for next generation
of commercially available SSL luminaires



More Info on CPTP

- Via website
 - Summary reports
 - Detailed reports
 - Must be requested via web form
 - Requestor's contact information must be provided
 - Must agree to adhere to 'No Commercial Use Policy'



http://www.netl.doe.gov/ssl/comm_testing.htm



No Commercial Use Policy

The U.S. Department of Energy (DOE) is a federal agency working in the public interest. Published information from the DOE SSL Commercial Product Testing Program, including test reports, technical information, and summaries, is intended solely for the benefit of the public, in order to help buyers, specifiers of new SSL products, testing laboratories, energy experts, energy program managers, regulators, and others make informed choices and decisions about SSL products and related technologies. **Such information may not be used in advertising, to promote a company's product or service, or to characterize a competitor's product or service.** This policy precludes any commercial use of any DOE SSL Commercial Product Testing Program published information in any form without DOE's express written permission.



Questions & Answers

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DOE SSL Website: www.netl.doe.gov/ssl/